Production of neutron-rich nuclei towards the r-process path in peripheral heavy-ion collisions at 15 MeV/nucleon

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Abstract
Neutron-rich nuclides have traditionally been produced in spallation reactions, fission and "cold" projectile fragmentation. Apart from these main production approaches, the search for new synthetic routes is currently of importance to nuclear studies towards the neutron-drip line. Towards this goal, we have undertaken a systematic study of the production cross sections of neutron-rich rare isotopes from binary collisions of neutron-rich beams on heavy neutron-rich targets at energies below the Fermi energy (see recent works, e.g., [1-4]).

Recently, the reactions of 15 MeV/nucleon ^{86}Kr and ^{40}Ar beams on ^{64}Ni, ^{58}Ni and ^{124}Sn, ^{112}Sn targets have been studied in detail using the MARS recoil separator at the Cyclotron Institute of Texas A&M University. We observed large production cross sections of neutron-rich projectile residues in the reactions involving the neutron-rich targets compared to the expectations from similar reactions at high-energy (projectile fragmentation, as well as, compared to the reactions with the neutron-poor targets at the present energy. We are currently employing a hybrid model based on a deep-inelastic transfer (DIT) code followed by a statistical de-excitation code to describe the data. From a practical viewpoint, we indicate that such reactions offer an attractive approach with high-intensity stable beams, as well as, in two-stage production schemes (namely, by using a neutron-rich radioactive beam on a neutron-rich target). Estimates of production rates of representative very neutron-rich isotopes will be presented. Finally, possibilities of nuclear structure and reaction studies that may be offered by re-accelerated radioactive beams at present and future radioactive beam facilities will be outlined.

1. G.A. Souliotis et al., Phys. Lett. B 543 (2002) 163.
2. G.A. Souliotis et al., Nucl. Instrum. and Methods B 204 (2003) 166.
3. G.A. Souliotis et al., Phys. Rev. Lett. 91 (2003) 022701.
4. G.A. Souliotis et al., Nucl. Instrum. and Methods B 266 (2008) 4692.